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Restoring the Nitrogen Cycle in the Boreal Forest – a Case Study from Northern Alberta

Jacynthe Masse (1), Sue Grayston (1), Cindy Prescott (1), and Sylvie Quideau (2)

(1) Faculty of Forestry, University of British-Columbia, Vancouver, Canada (jacynthe.masse@alumni.ubc.ca), (2) Department of Renewable Resources, University of Alberta, Edmonton, Canada (sylvie.quideau@ualberta.ca)

The Athabasca oil sands deposit, located in the boreal forests of Northern Alberta, is one of the largest single oil deposits in the world. This deposit rests underneath 40,200 square kilometres of land. To date, an area of about 715 square kilometres has been disturbed by oil sands mining activity (Government of Alberta, 2013). Following surface mining, companies have the legal obligation to restore soil-like profiles that can support the previous land capabilities (Powter et al., 2012). Because of its importance for site productivity, re-establishment of the nitrogen cycle between these reconstructed soils and plants is one of the most critical factors required to insure long term sustainability of reclaimed boreal landscape.

High nitrogen deposition recorded in the oil sands area combined with the high level of nitrate found in reclaimed soils raised concerns about the possibility of these reclaimed soils being in early stages of N saturation (Laxton et al 2010; Hemsley, 2012), although little evidence of net nitrification in these reclaimed soils suggests the contrary (Laxton et al. 2012). To date, results on the behaviour of the nitrogen cycle in the reclaimed sites are contradictory. A systematic study of the nitrogen cycle, and especially rates of gross mineralization, nitrification and denitrification, is needed. Our research aimed at 1) measuring the gross rates of nitrogen transformations under different vegetation treatments in both reclaimed and naturally-disturbed (fire) sites and 2) characterizing the microbial communities participating in the nitrogen cycle within the same soils.

A series of 20 soils, covering different vegetation treatments (plots planted with aspen (Populus tremuloides), spruce (Picea glauca) and grassland) were investigated. Gross nitrogen transformation rates were measured using 15N pool-dilution (Müller et al. 2007). Microbial communities participating in the N-cycle were characterized using qPCR and pyrosequencing. Differences between nitrogen cycling processes in the different vegetation treatments and in the naturally disturbed sites were found. The reasons for these variances will be discussed.

The oil sands will be Canada's environmental legacy for the next several hundred years and recreating functional soils is fundamental to our ability to restore boreal ecosystems after disturbance.